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1955

The ability of a ninth grade science class  
to learn selected biological principles in a  
limited time.



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Thesis

THE ABILITY OF A NINTH GRADE SCIENCE CLASS  
TO LEARN SELECTED BIOLOGICAL PRINCIPLES IN  
A LIMITED TIME

by

Donald Darsch  
(A.B. Eastern Nazarene College, 1951)

In Partial Fulfillment  
of the Requirements for the Degree  
of Master of Education

August, 1955

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## CHAPTER I

### THE PURPOSE OF THIS STUDY

#### Introduction

The volume of scientific information has been increasing in late years until today it is difficult for men, even in special fields of study, to keep pace with the array of data around them. Also, as the influence of science becomes greater and greater on the individual it becomes a moral issue in the lives of men.

As with everywhere else the tremor of this influence has been felt in the schools so that science teachers must spend more time reading the latest periodicals, attending special classes, and devising ways to demonstrate the findings of scientists in the field. Children are well aware of current events in the fascinating times in which they live and often it is a race against time for the teacher to have answers for their questions about the latest advancements.

In science teaching, then, we are coming to the time of streamlining our curriculum so that we can pack more learning experiences into our twelve year program. Perhaps we should assume children have had more outside learning experiences than we have given them credit for. All children must be

CHAPTER I  
THE PURPOSE OF THIS STUDY

Introduction

The volume of scientific information has been increasing in these years and it is difficult for even an expert to keep up with the rate of change. Also, as the importance of science becomes greater and greater in the life of the nation, it is more and more important that the citizen should have a knowledge of the science of his time. It is the purpose of this study to determine the extent to which the average citizen is acquainted with the science of his time. This study is a part of a larger study which is being conducted by the National Science Foundation. The results of this study will be used to determine the need for science education in the home and in the school. It is hoped that this study will help to bring about a better understanding of the science of our time and thus help to bring about a better life for all.

given a well rounded understanding of the whole of science. The recent developments in science should not be assigned as special studies for the gifted few but should be interpreted for the understanding of all. To gain time to do this, more efficient teaching of material considered to be important is necessary. An attempt to raise the efficiency of a small segment of instruction is now to be reported.

### Statement of the Problem

The purpose of this study is to show that in a limited period of time ninth grade science students can be thoroughly taught selected principles of biology. More specifically, using the biological items of the Read General Science Test,<sup>1/</sup> the students were given a pretest and a post test before and after a ten week period of biology instruction to measure their ability thoroughly to comprehend 19 concepts of biology specifically covered by the test.

### Justification of the Problem

The writer was first stimulated to study this problem by Dr. Read<sup>2/</sup> to find out if ninth graders could thoroughly learn selected biology principles in a limited time. It has been the author's opinion for some time that the junior high school science program could be revised to include more

<sup>1/</sup>John G. Read, Read General Science Test, World Book Co., Yonkers-on-Hudson, 1951.

<sup>2/</sup>J. G. Read, Prof. of Science Ed., Boston University.



details on current science issues and less time on basic principles we have accepted for so long. In so doing we could reserve time in the junior high science period to be used in studying current developments. This process would give us better informed citizens and increase the interest of boys and girls to further science study.

This study is warranted, it is felt, if it can be shown that students can learn the basic concepts of a course even in a limited time by teaching those concepts thoroughly.

#### Scope of the Study

This study was conducted with a ninth grade class of 19 students whose homes were in 15 different towns near Boston. They were not chosen to form a class for this study but were students in a private school in Cambridge, Massachusetts. The writer, their regular science instructor, interrupted the normal curriculum to give them a special study in ninth grade biology.

The study was special in that the biological principles toward which the course was taught were taken from the Read General Science Test referred to in the statement of the problem. The validity and reliability of the items are reported in the manual of directions for the test.

Out of 75 items in each form of the test, 19 were on some phase of biology. In fact, each of the 19 items was concerned with a highly valid biological principle. In determining the



objectives and content of the test the following sources were utilized:

1. Eleven widely used textbooks.
2. Representative state curricula and samples of course of study prepared under the direction of outstanding consultants in the field of science education.
3. National Society for the Study of Education. Thirty-first Yearbook, Part I. A Program of Teaching Science. Public School Publishing Company: 1932.
4. National Society for the Study of Education. Forty-sixth Yearbook, Part I. Science Education in American Schools. University of Chicago Press: 1947.

In addition to this the preliminary forms of the test, including these 19 items, were administered to 1600 students in 12 high schools in eight states. Pupils had a mean IQ of 102. The mean IQ of the group used in this experiment was 106. Considering all 75 items the mean validity index of items in Form Am is .42 and in Form Bm, .43.

The Am form was given as a pretest and ten weeks later the Bm form was given as a post test.

1. The following are the names of the persons who were

present:

1. Mr. W. H. Rouse

2. Mr. J. H. Rouse

3. Mr. J. H. Rouse

4. Mr. J. H. Rouse

5. Mr. J. H. Rouse

6. Mr. J. H. Rouse

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18. Mr. J. H. Rouse

19. Mr. J. H. Rouse

20. Mr. J. H. Rouse

21. Mr. J. H. Rouse

## CHAPTER II

### REVIEW OF RESEARCH

#### Construction of the Read General Science Test<sup>1/</sup>

The test was designed to be a comprehensive measure of ninth grade achievement in general science. Also it was made to be used as a pretest at the beginning of the seventh grade and a post test at the end of ninth grade general science.

The test is one of the Evaluation and Adjustment Series<sup>2/</sup> developed for publication by the World Book Company. Tests in each major subject-matter area were prepared under the direction of Dr. Victor H. Noll, Michigan State College. The general editor for the entire series was Dr. Walter N. Durost of Boston University. The experimental work here described was under the direction of Mr. Roger T. Lennon, Director of the Division of Test Research and Service, World Book Company.

#### Development of the Test

The first problem was to determine the objectives of the test and their relative importance to each other. To determine these objectives several sources were used.

<sup>1/</sup>"Construction and Evaluation of a New General Science Test" John G. Read, School of Ed., Boston University, Boston, Mass., Science Education, Vol.35, No. 5, December, 1951, pp. 262-266.

<sup>2/</sup>Evaluation and Adjustment Series, World Book Company, Yonkers-on-Hudson, New York.



First of all, eleven widely used text books were reviewed. These books, written between 1939 and 1949 by experienced science teachers, were considered a valid guide as to what was being taught in general science throughout the country.

Table 1. Percentage Content of Biological Topics of Eleven Texts in General Science Compared with Content on Final Forms A and B

Topic	Text Books Reviewed %	Form A Form B%	No. of Items in Each Area	
			Form A	Form B
Bacteria.....	7	7.5	5	6
Human Body, Food.....	11	6.5	6	6
Conservation Important Plants & Animals	10	10.	8	7

Table 1 has been condensed to include only the biological topics since these topics are the delimitation of this thesis. The table summarizes information on the proportionate assignment of space to the biological topics and for comparison the proportion of questions by topic in the two final forms of the test.

A second source of information to determine objectives for the Read General Science Test was the various general science courses of study used in cities and state courses of study. These syllabi contained far more material than could be covered in the science-hour schedule. Also there was no way of knowing which topics were covered in a given science class.

These books, written between 1925 and 1940 by experienced scientists, were considered a valid guide as to what was being taught in general science at that time and the country.

Table 1. Percentage of coverage of biological topics in general science textbooks in the United States and Canada, 1925-1940.

Topic	General Science Textbooks Reviewed	Form A Form B	Form A Form B
Botany.....	7	1.5	0
Zoology.....	11	2.5	0
Physiology.....	10	10	0
Plant Physiology.....	10	10	0

Table 1 has been condensed to include only the biological topics since these topics are the definition of this study. The data indicates information on the proportionate assignment of space to the biological topics and the comparison the proportion of questions by topic in the two final forms of the test.

A second source of information to determine objectives for the test was the textbook content and was the various general sciences as well as which topics were covered in the various general sciences. These subjects contained the material that would be covered in the subject-matter content. Also there was no way of knowing which topics were covered in a given science class.

Still another source for determining objectives was the recommendations of yearbooks and committee reports in the field of general science in the past twenty years.

From these sources of information as to the present general science course content throughout the country a blue print was made. (See Table 2.) From this blue print test items were constructed for three experimental tests of 90 items each.

Test	1	2	3	4	5	6
Final Test						
Test 1	85%	83%	82%	81%	80%	79%
Test 2	84%	82%	81%	80%	79%	78%
Average Score	84.5%	82.5%	81.5%	80.5%	79.5%	78.5%

Still another reason for the increasing objectivity was  
the more systematic of methods and systematic records in  
the field of general science in the past twenty years.  
From these sources of information as to the present  
general science source content throughout the country a  
this point was made. Also Table 2.1. From this the point  
that there was considerable for these experimental cases  
of 50 cases each.

Table 2. Composition of Original and Final Forms of Test as the Objectives

	I.To Achieve Understand- ing of Functional		II.To Achieve Skill in			To Demon- strate a.Scientific Attitudes
	a.Facts	b.Concepts	a.Reading Charts and Graphs	Problem Solving	Complex Problem Solving	
Column	1	2	3	4	5	6
Original Test	20%	30%	18%	16%	11%	5%
Final Test Form A	33%	33%	12%	7.5%	8%	6.5%
Form B	32%	34%	12%	8.0%	7.5%	6.5%
Average Form A and B	32.5%	33.5%	12%	7.75%	7.75%	6.5%



### Preliminary Tryout

In the spring of 1949 these three preliminary tests were tried on 1613 students in 14 schools in 34 classes from Maine to Iowa. The tests were given by the regular teachers in these schools. At the same time the Terman-McNemar Test of Mental Ability was given to these students. The result showed a mean I.Q. of 102.42 with a standard deviation of 15.26. From the selection of students and the mean I.Q. of 102 it is believed this group was representative of ninth graders.

The preliminary tryout was useful in determining the difficulty value for each item and its validity. It also showed which items were objectionable for one reason or another.

Construction of the final form of the test became a job of selecting items from the preliminary test as to difficulty and discriminating power while maintaining proper distribution of content. Two final tests then were constructed with item difficulty averages of 53% on each test. This is very close to the 58% average considered best for a maximum of reliability and differentiation.

The item validity used was the Flanagan approximation of the product-moment correlation between items and the total score computed from the percent passing in the upper and lower 27 percent of the tryout group. The average validity coefficient of the two final forms was 0.414 for Form A and 0.427 for Form B.

Introduction

The purpose of this study is to investigate the relationship between the variables of interest. The study is designed to provide a comprehensive overview of the topic and to identify the key factors that influence the outcome. The research is based on a review of the literature and the analysis of data collected from various sources. The findings of the study are presented in the following sections.

The study is organized into several chapters. Chapter 1 provides an overview of the research and its objectives. Chapter 2 discusses the theoretical framework and the hypotheses. Chapter 3 describes the methodology and the data collection process. Chapter 4 presents the results of the analysis. Chapter 5 discusses the implications of the findings and the conclusions.

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The final forms were limited to 75 items each since the test was designed to be handled in a 40 minute period. The items were constructed to match in pairs between the Am and the Bm forms.

### Results of Tryouts

In general the final tests corresponded to the texts used in the field. Some differences between tests and textbooks used were due to items being non-functional or to the effort to stay within a 75 item limit. The greatest difference was in the topic Human Body and Foods. Other differences in the test as a whole were in the topics Water and Work and Machines. These topics, however, are outside the scope of this paper. A reason for having a low percentage of questions on biology may be due to the feeling that many ninth graders go on to biology in the tenth grade. Also, topics covered in hygiene and health studies of the lower grades would overlap ninth grade biology and some teachers may feel they need not give much attention to this area.

The ratio between biological and physical questions was 30%:70%. Although Table 2 was used as a blue print for the test, some departure was made from it when a departure meant more valid questions on the final tests. From Table 2 we can note the greatest increase in Functional Facts (20% to 32.5%) and Scientific Attitude (5% to 6.5%).

In conclusion it must be said that the items ranged in difficulty so that the best students would not finish the

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### Section 10

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the ninety-seventh is the fact that the  
the ninety-eighth is the fact that the  
the ninety-ninth is the fact that the  
the hundredth is the fact that the

test. However, with some of the items at a difficulty index of 0.2+ even poor students could do some of the test.

The school may not be responsible for high scores by bright students. Many pupils have extra-curricular activities which enable them to make a good showing. Students doing well on the Read General Science Test and corresponding mathematics tests should be encouraged toward further science study.



## CHAPTER III

### PROCEDURE

#### Restatement of the Problem

This study was conducted to determine the ability of ninth grade students to learn the biological principles considered essential for their grade level.

#### Method of Procedure

From Martin's<sup>1/</sup> three hundred major biological principles eighty were chosen in a study by Berman<sup>2/</sup> to be representative of Martin's list. These eighty were then evaluated as to their inclusion in a general biology course, whether they were essential, desirable, optional or not suitable. From this break-down about 47 principles were considered essential and desirable. Nineteen of these principles have been related to 19 biology items on the Read General Science Test in this study. The ten week teaching period was then organized to cover these principles without direct reference to the questions on the test. The validity of these 19 items, then, is justified from two points of view. (1) They

1/Martin, William Edgar, A Determination of the Principles of The Biological Science of Importance for General Education, Unpublished Doctor's Dissertation, University of Michigan, 1944.

2/Berman, Herbert Joshua, Evaluation of Eighty Biological Principles for a General High School Biology Course by a File Card Technique, Unpublished Master's Thesis, Boston University, 1950.

1911

1912

1913

1914

1915

1916

1917

1918

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1924

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1926

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1928

1929

1930

1931

1932

1933

correspond to 19 of the highly valid 80 principles mentioned and (2) are justified on their own grounds as explained in the scope of this study, Chapter I.

The Am form of the test was given at the beginning of this period and the Bm form was given after these principles were covered. The experimenter was then able to determine the percentage of growth of each child and the degree to which each principle was learned by the entire class. The two tests were similar in difficulty with corresponding items which could be matched. Table 3 shows these items, matched and listed according to their difficulty of comprehension as determined by a standard technique.

The sequence in which the principles were studied generally followed the order in which they appeared in the text<sup>1/</sup> the students were using in their regular ninth grade science course. All of the principles received approximately the same emphasis. If the study were to be repeated it would perhaps be best to give more attention to those items found, in this study, to have a greater difficulty index. (See Table 3.)

1/Wood and Carpenter, Our Environment: How We Use and Control It, Allyn and Bacon, Boston, 1952.



Table 3. A Comparison of the 19 Matched Biological Items from the Read General Science Test and 19 Principles from Berman's List of Eighty Principles. Items from the Am pretest are Listed According to Difficulty

( - indicates the right answer)

Biological Items from Am Pre-Test	Biological Items from Bm Post Test	Principles from Berman's List
<p>1. Which one of the following statements is FALSE?</p> <ol style="list-style-type: none"> <li>1. It is better never to drink when driving.</li> <li>2. It is practically certain that alcohol will slow down your reaction time.</li> <li>3. Alcohol is considered to be a poor food.</li> <li>- 4. Everyone can take one drink without having it affect him.</li> <li>5. Alcohol is often habit-forming.</li> </ol>	<p>1. A famous laboratory discovered that alcohol even in small amounts will slow down a man's "reaction time" by as much as 20 per cent. An automobile driver who has had a drink has an accident. In the police court, the most scientific statement for him to make is:</p> <ol style="list-style-type: none"> <li>1. "Alcohol never bothers me."</li> <li>2. "I was driving carefully."</li> <li>3. "The weather was good and I could see the road way ahead."</li> <li>4. "I didn't have time to stop."</li> <li>- 5. "I shall depend on the doctor's report of my condition at the time of the accident."</li> </ol>	<p>1. Cells within an organism are dependent upon their environment, as well as their genes, in the process of becoming what they finally become.</p>
<p>2. Pasteur is known for his work with:</p> <ol style="list-style-type: none"> <li>1. electricity</li> <li>- 2. bacteria</li> <li>3. molds</li> <li>4. radium</li> <li>5. X-Rays</li> </ol>	<p>2. The terms of which pair belong together?</p> <ol style="list-style-type: none"> <li>1. Lister - yellow fever</li> <li>2. Reed - antisepsis</li> <li>- 3. Pasteur - bacteria</li> <li>4. Jenner - radium</li> <li>5. Curie - smallpox</li> </ol>	<p>2. Most cases of fermentation, souring and putrefaction are brought about by living micro-organisms.</p>

(continued on next page)

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...the ... of the ...  
...the ... of the ...  
...the ... of the ...

1 - [illegible text]

[illegible text]

1. [illegible text]  
2. [illegible text]  
3. [illegible text]  
4. [illegible text]  
5. [illegible text]  
6. [illegible text]  
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10. [illegible text]

1. [illegible text]  
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5. [illegible text]

(illegible text)

Table 3. (continued)

Biological Items from Am Pre-Test	Biological Items from Bm Post Test	Principles from Berman's List
<p>3. Two explorers measured the height of the same mountain in Alaska - one in 1898, and the other in 1940. Their results were different by over 500 feet. Which one of the following best explains this discrepancy?</p> <ol style="list-style-type: none"> <li>1. The 1898 figure was obtained in the summer.</li> <li>2. The 1940 figure was obtained in the winter.</li> <li>3. The 1898 figure was obtained by climbing the mountain.</li> <li>4. The 1940 survey was by airplane, using photographic mapping.</li> <li>- 5. None of the above gives a completely satisfactory explanation.</li> </ol> <p>4. Which one of the following is most necessary for proper growth of the bones?</p> <ol style="list-style-type: none"> <li>- 1. calcium</li> <li>2. iron</li> <li>3. fluorine</li> <li>4. iodine</li> <li>5. carbon</li> </ol>	<p>3. The dust storms of the Great Plains and the deserts carry soil for miles. As the velocity of the wind dies down, which particles of material are deposited first?</p> <ol style="list-style-type: none"> <li>- 1. The heaviest</li> <li>2. The driest</li> <li>3. The lightest</li> <li>4. The smallest</li> <li>5. The smoothest</li> </ol> <p>4. Of the following, the most important source of calcium is:</p> <ol style="list-style-type: none"> <li>1. potato</li> <li>2. meat</li> <li>3. celery</li> <li>4. chocolate</li> <li>- 5. milk</li> </ol>	<p>3. Only the topsoil, with its rich organic matter, its porous structure, and its living organisms, can hold the water and provide the minerals necessary to the life of the plant.</p> <p>4. An organism must have certain materials for its life processes and each organism must secure the required materials that it cannot build for itself.</p>

(continued on next page)

1. The first...

2. The second...

3. The third...

4. The fourth...

- 1. The first...
- 2. The second...
- 3. The third...
- 4. The fourth...
- 5. The fifth...

5. The fifth...

6. The sixth...

7. The seventh...

- 1. The first...
- 2. The second...
- 3. The third...
- 4. The fourth...
- 5. The fifth...

- 1. The first...
- 2. The second...
- 3. The third...
- 4. The fourth...
- 5. The fifth...

Table 3. (continued)

Biological Items from Am Pre-Test	Biological Items from Bm Post Test	Principles from Berman's List
<p>5. Which one of the following does NOT usually carry bacteria which are harmful to man?</p> <ol style="list-style-type: none"> <li>1. ticks</li> <li>2. flies</li> <li>3. mosquitoes</li> <li>4. fleas</li> <li>- 5. bees</li> </ol>	<p>5. Which one of the following insects is most likely to be a carrier of malaria germs?</p> <ol style="list-style-type: none"> <li>1. fly</li> <li>2. ant</li> <li>- 3. mosquito</li> <li>4. flea</li> <li>5. bee</li> </ol>	<p>5. A characteristic of many parasites is that they have alternate hosts.</p>
<p>6. It is possible to contract tuberculosis ONLY if one -</p> <ol style="list-style-type: none"> <li>1. loses weight</li> <li>- 2. comes in contact with the tuberculosis bacillus</li> <li>3. gets overtired</li> <li>4. does not get enough fresh air at night</li> <li>5. is bitten by a certain kind of mosquito</li> </ol>	<p>6. A person can be sure that he is free from active pulmonary (lung) tuberculosis ONLY by having:</p> <ol style="list-style-type: none"> <li>1. yearly skin tests</li> <li>2. radium treatments</li> <li>3. a blood test</li> <li>4. a throat examination</li> <li>- 5. yearly chest X-rays</li> </ol>	<p>6. All communicable diseases are caused by micro-organisms.</p>
<p>7. Penicillin is obtained from:</p> <ol style="list-style-type: none"> <li>- 1. molds</li> <li>2. bacteria</li> <li>3. vaccines</li> <li>4. laboratory animals</li> <li>5. serums</li> </ol>	<p>7. Which one of the following bacteria-killing agents comes from a mold?</p> <ol style="list-style-type: none"> <li>1. sulfadiazine</li> <li>- 2. penicillin</li> <li>3. iodine</li> <li>4. hydrogen peroxide</li> <li>5. ammonia</li> </ol>	<p>7. The fundamental life processes are the same in all organisms, but each species has other chemical processes peculiar to itself.</p>

(continued on next page)

1. The first part of the report is a summary of the work done during the year.

2. The second part of the report is a detailed account of the work done during the year.

3. The third part of the report is a summary of the work done during the year.

4. The fourth part of the report is a detailed account of the work done during the year.

5. The fifth part of the report is a summary of the work done during the year.

6. The sixth part of the report is a detailed account of the work done during the year.

7. The seventh part of the report is a summary of the work done during the year.

Table 3. (continued)

Biological Items from Am Pre-Test	Biological Items from Bn Post Test	Principles from Berman's List
<p>8. If an extremely long-needled variety of pine tree produces some cones whose seeds grew into short-needled trees, it indicated that -</p> <ol style="list-style-type: none"> <li>1. The parent pine tree was getting old.</li> <li>2. There was not enough rain that year.</li> <li>3. Pollen from a hemlock tree reached the long-needled tree.</li> <li>- 4. Pollen from a short-needled pine fertilized the long-needled tree.</li> <li>5. The seed of the pine was damaged by squirrels.</li> </ol>	<p>8. Geraniums can be started by cutting a "slip" from a plant and rooting it in sand. If a red geranium is "slipped" and grown in sand between a white geranium and a salmon-colored one, the slip will produce a bloom which is -</p> <ol style="list-style-type: none"> <li>1. salmon-red</li> <li>2. pink</li> <li>3. salmon-red and pink</li> <li>4. white</li> <li>- 5. red</li> </ol>	<p>8. Sexual union in plants and animals affords a method of variation due to the mixing of different protoplasts.</p>
<p>9. About every seven years every one should be vaccinated against:</p> <ol style="list-style-type: none"> <li>1. typhoid fever</li> <li>2. diphtheria</li> <li>- 3. smallpox</li> <li>4. influenza</li> <li>5. colds</li> </ol>	<p>9. The most effective way eventually to wipe out smallpox in the United States is through:</p> <ol style="list-style-type: none"> <li>1. quarantines during smallpox epidemics</li> <li>2. regular health inspections in schools</li> <li>3. inspection of foods</li> <li>- 4. vaccination of all children</li> <li>5. chlorination of drinking water</li> </ol>	<p>9. The antitoxine produced by the body of an organism are specific.</p>

(continued on next page)

1. The first of the three

2. The second of the three

3. The third of the three

4. The fourth of the three

5. The fifth of the three

6. The sixth of the three

7. The seventh of the three

8. The eighth of the three

9. The ninth of the three

10. The tenth of the three

11. The eleventh of the three

12. The twelfth of the three

13. The thirteenth of the three

14. The fourteenth of the three

15. The fifteenth of the three

16. The sixteenth of the three

17. The seventeenth of the three

18. The eighteenth of the three

19. The nineteenth of the three

20. The twentieth of the three

21. The twenty-first of the three

22. The twenty-second of the three

23. The twenty-third of the three

24. The twenty-fourth of the three

25. The twenty-fifth of the three

26. The twenty-sixth of the three

27. The twenty-seventh of the three

28. The twenty-eighth of the three

29. The twenty-ninth of the three

30. The thirtieth of the three

31. The thirty-first of the three

32. The thirty-second of the three

33. The thirty-third of the three

34. The thirty-fourth of the three

35. The thirty-fifth of the three

36. The thirty-sixth of the three

37. The thirty-seventh of the three

38. The thirty-eighth of the three

39. The thirty-ninth of the three

40. The fortieth of the three

41. The forty-first of the three

42. The forty-second of the three

43. The forty-third of the three

44. The forty-fourth of the three

45. The forty-fifth of the three

46. The forty-sixth of the three

47. The forty-seventh of the three

48. The forty-eighth of the three

49. The forty-ninth of the three

50. The fiftieth of the three

51. The fifty-first of the three

52. The fifty-second of the three

53. The fifty-third of the three

54. The fifty-fourth of the three

55. The fifty-fifth of the three

56. The fifty-sixth of the three

57. The fifty-seventh of the three

58. The fifty-eighth of the three

Table 3. (continued)

Biological Items from Am Pre-Test	Biological Items from Bm Post Test	Principles from Berman's List
<p>10. A vital factor in producing a new variety of tomatoes is:</p> <ol style="list-style-type: none"> <li>1. selection of the best seed</li> <li>2. self-pollination</li> <li>3. good soil</li> <li>4. plenty of moisture</li> <li>- 5. cross-pollination</li> </ol>	<p>10. In developing a new blueberry, which one of the following methods is most apt to produce a sweeter, larger berry?</p> <ol style="list-style-type: none"> <li>1. plant cuttings of very sweet berries near cuttings of large berries</li> <li>- 2. cross-pollinate very sweet berries with very large berries</li> <li>3. self-pollinate very sweet berries</li> <li>4. self-pollinate very large berries</li> <li>5. mix the seeds of very sweet berries with those of very large berries and plant them together.</li> </ol>	<p>10. The sex chromosomes may carry the genes for a number of characters other than sex. Such characters are sex-linked.</p>
<p>11. A green vegetable like lettuce is valuable in the diet because it supplies:</p> <ol style="list-style-type: none"> <li>1. carbohydrates</li> <li>2. fats</li> <li>3. proteins</li> <li>- 4. vitamins</li> <li>5. all of the above</li> </ol>	<p>11. When starchy foods are eaten, they are usually first changed by a digestive process that begins in the -</p> <ol style="list-style-type: none"> <li>1. stomach</li> <li>2. small intestine</li> <li>- 3. mouth</li> <li>4. liver</li> <li>5. pancreas</li> </ol>	<p>11. Starches, fats and proteins are produced by plants and it is upon these that all animals depend primarily for food.</p>
<p>12. The process shown above at Y is called:</p> <ol style="list-style-type: none"> <li>- 1. self-pollination</li> <li>2. cross-fertilization</li> <li>3. mutation</li> <li>4. cell division</li> <li>5. budding</li> </ol>	<p>12. The process shown above at X is called:</p> <ol style="list-style-type: none"> <li>1. self-pollination</li> <li>2. self-fertilization</li> <li>3. cell division</li> <li>4. budding</li> <li>- 5. cross-pollination</li> </ol>	<p>12. In sexual reproduction, a male cell from one parent unites with a female cell from the other parent to produce the young (except in the few cases of self-fertilization).</p>

(continued on next page)



Table 3. (cont inued)

Biological Items from Am Pre-Test	Biological Items from Em Post Test	Principles from Berman's List
<p>13. The distinctive shape of "Green Mountain" potatoes is due primarily to the -</p> <ol style="list-style-type: none"> <li>1. amount of cultivation they receive</li> <li>2. amount of rainfall</li> <li>- 3. hereditary character of the seed potatoes</li> <li>4. amount of fertilizer applied</li> <li>5. temperature during the growing season</li> </ol>	<p>13. The distinctive bright red color of ripe "John Baer" tomatoes depends primarily on the -</p> <ol style="list-style-type: none"> <li>1. amount of rainfall</li> <li>2. amount of sunshine</li> <li>3. temperature</li> <li>- 4. hereditary character of the seed</li> <li>5. amount of fertilizer used</li> </ol>	<p>13. Heredity supplies the native capacities of an organism; environment determines to a large extent how fully these capacities will be developed.</p>
<p>14. Most erosion in the upper Mississippi Valley was caused by the -</p> <ol style="list-style-type: none"> <li>1. mining of iron</li> <li>2. mining of coal</li> <li>- 3. cutting of timber</li> <li>4. building of dams</li> <li>5. building of hydroelectric plants</li> </ol>	<p>14. The most effective way to prevent future floods in hilly country where lumbering is a major industry is to -</p> <ol style="list-style-type: none"> <li>- 1. Reforest after cutting mature trees.</li> <li>2. Make ditches.</li> <li>3. Build dams.</li> <li>4. Build restraining levees.</li> <li>5. Build hydroelectric plants.</li> </ol>	<p>14. All plant and animal life, along with the climate and varying weather, play an active part in helping to form and to change the soil.</p>
<p>15. If a friend says, "Oh, nobody in my family ever had diphtheria, so I won't ever have it," you might properly make all EXCEPT which one of the following statements?</p> <ol style="list-style-type: none"> <li>1. "We can ask the school doctor about diphtheria."</li> <li>2. "Let's look it up in a health book."</li> <li>3. "I had the diphtheria toxoid and now I probably won't have diphtheria."</li> <li>- 4. "Maybe you are right."</li> <li>5. "I don't believe that immunity from diphtheria is hereditary."</li> </ol>	<p>15. If a neighbor says she is not going to have her child given the Schick test to see if he is immune to diphtheria, as no one gets diphtheria nowadays, you should be willing to do all EXCEPT which of the following?</p> <ol style="list-style-type: none"> <li>- 1. Agree with her decision.</li> <li>2. Explain that the test is harmless.</li> <li>3. Tell her about the four cases in the local hospital.</li> <li>4. Ask her to request free information from the school doctor.</li> <li>5. Help her to arrange for a Schick test.</li> </ol>	<p>15. Infection by micro-organisms is possible only under the following conditions:</p> <ol style="list-style-type: none"> <li>1. The infecting organism must enter the host in sufficient number.</li> <li>2. It must enter by an appropriate avenue.</li> <li>3. It must be virulent.</li> <li>4. The host must be receptive.</li> </ol>

(continued on next page)



Table 3. (continued)

Biological Items from Am Pre-Test	Biological Items from Bm Post Test	Principles from Berman's List
<p>16. Tracks of dinosaurs left on the muddy banks of streams are found now as fossils. About how many years ago were they made?</p> <ol style="list-style-type: none"> <li>1. 1 thousand</li> <li>2. 10 thousand</li> <li>3. 50 thousand</li> <li>4. 100 thousand</li> <li>- 5. 1 million</li> </ol>	<p>16. Man has learned about plants and animals that lived long ago on the earth through the study of fossils found in:</p> <ol style="list-style-type: none"> <li>1. granite</li> <li>2. marble</li> <li>3. iron ore</li> <li>4. pumice</li> <li>- 5. shale</li> </ol>	<p>16. Fossils, dated by the rocks in which they are found, reveal portions of the actual history of life's past changes by a progression of forms from simple to complex.</p>
<p>17. Which one of the following has probably had the LEAST over-all effect in the breaking down of rocks into soil?</p> <ol style="list-style-type: none"> <li>1. running water</li> <li>2. wind, carrying sand</li> <li>3. tides</li> <li>- 4. explosives used by man</li> <li>5. chemical changes</li> </ol>	<p>17. Wind and running water are most effective in breaking down rocks into soil when they -</p> <ol style="list-style-type: none"> <li>1. are cool</li> <li>2. are warm</li> <li>3. move slowly</li> <li>- 4. carry sand</li> <li>5. are changing direction</li> </ol>	<p>17. The surface of the earth and the atmosphere surrounding the earth are undergoing constant changes..</p>
<p>18. If a completely new kind of melon appeared in a melon patch, and this new type of melon reproduced the same kind of melon from its seeds, the cause of this new type of melon probably was -</p> <ol style="list-style-type: none"> <li>1. injury to the melon blossom</li> <li>- 2. mutation</li> <li>3. an extra amount of fertilizer</li> <li>4. self-pollination</li> <li>5. cell division</li> </ol>	<p>18. Over a period of many years, Luther Burbank produced new fruits and vegetables by crossbreeding after careful -</p> <ol style="list-style-type: none"> <li>1. mutation</li> <li>2. pruning</li> <li>3. X-raying</li> <li>- 4. selection</li> <li>5. self-pollination</li> </ol>	<p>18. All heritable variations, which are not the results of recombinations of genes, are mutations which are changes in genes, in some cases induced by environmental agents.</p>

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10. (continued)

10. (continued)

10. (continued)

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Table 3. (concluded)

Biological Items from Am Pre-Test	Biological Items from Bm Post Test	Principles from Berman's List
<p>19. Which one of the following is NOT a legume?</p> <ol style="list-style-type: none"> <li>1. string beans</li> <li>2. soybeans</li> <li>- 3. corn</li> <li>4. clover</li> <li>5. alfalfa</li> </ol>	<p>19. Legumes can take nitrogen from the air with the aid of certain -</p> <ol style="list-style-type: none"> <li>- 1. bacteria</li> <li>2. chemicals in the soil</li> <li>3. cultivation methods</li> <li>4. temperature changes</li> <li>5. molds</li> </ol>	<p>19. An animal cannot live without proteins. They are necessary in cell growth and maintenance; so, are necessities in the diets of animals. Plants are able to use carbohydrates and nitrates to build up the proteins necessary for growth and maintenance of their cells.</p> <p>Three concepts. (a) Essential amino acids (proteins) are necessary to build and maintain tissues. (b) Plants can build their own essential amino acids (proteins) from carbohydrates and nitrates. (c) Animals are dependent, directly or indirectly, on plants for their essential amino acids (proteins).</p>



### Detail of Daily Procedure

The ten week period was chosen to allow sufficient time to cover the principles found in Table 3. During this period the classes met for one forty-five minute period five days each week. This period came after lunch and was the fifth period in the daily schedule.

The children were not told that they were being used for a special study.

Many sensory aids were included in the daily lesson plans. It is the author's belief that whenever possible a principle should be demonstrated. Sometimes when this was not convenient films or film strips were shown. Several field trips were taken to nearby points of interest. The children gave reports and conducted experiments also. This active approach to the subject matter proved stimulating to students and teacher alike. Thus with the aid of increased interest, the learning experience was more profitable than a passive lecture-type program could be. Table 4 shows the sensory aids used with the different principles.

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Table 4. A Comparison of 19 Principles Found in Berman's List of 80 Biological Principles and Some Teaching Aids Used in Teaching Them

Principles from Berman's List	Some Teaching Aids Used
1. Cells within an organism are dependent upon their environment.	1.(a) White mouse given whiskey-soaked meat - its reactions noticed. (b) Plant grown in window. (c) Yeast cells placed in sugar solution - carbon dioxide collected.
2. Most cases of fermentation, souring and putrefaction are brought about by living micro-organisms.	2.(a) Peaches canned in class under sterile and un-sterile conditions. Results noted. (b) Certain foods allowed to spoil under various conditions.
3. Only the topsoil, with its rich organic matter, its porous structure, and its living organisms, can hold the water and provide the minerals necessary to the life of the plant.	3.(a) Film shown on soil erosion. (b) Fossils shown to class. (c) Reports given by two students. (d) Various types of soil examined for plant and animal life.
4. An organism must have certain materials for its life processes and each organism must secure the required materials that it cannot build for itself.	4.(a) Two white mice raised, one on diet including milk, the other on non-milk diet. Results noted. (b) Plants grown in several types of soil. (c) Photos showing effects of various types of nutritional deficiencies.

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Table 4. (continued)

Principles from Berman's List	Some Teaching Aids Used
5. A characteristic of many parasites is that they have alternate hosts.	5.(a) Film strips shown on several parasitic diseases. (b) Oral reports by three students.
6. All communicable diseases are caused by micro-organisms.	6.(a) Film strip on tuberculosis. (b) Written reports on communicable diseases. (c) Photos shown with opaque projector.
7. The fundamental life processes are the same in all organisms, but each species has other chemical processes peculiar to itself.	7.(a) Reports on several miracle drugs. (b) Photos of penicillin shown. (c) Several common molds grown for comparison.
8. Sexual union in plants and animals affords a method of variation due to the mixing of different protoplasts.	8.(a) Charts showing variations due to mixing hereditary characteristics. (b) Visit to Harvard Museum to note plant hereditary differences.
9. The antitoxine produced by the body of an organism are specific.	9.(a) Film strip on smallpox. (b) Reports on life of Edward Jenner.
10. The sex chromosomes may carry the genes for a number of characters other than sex. Such characters are sex-linked.	10.(a) Chart used showing sex-linked characteristics. (b) Several children made studies of their own families.
11. Starches, fats and proteins are produced by plants and it is upon these that all animals depend primarily for food.	11.(a) Many foods tested to see if they contained starches, proteins and oils.

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Table 1. (continued)

Date	Time	Description of event	Remarks
10/10/55	10:00	Arrived at the station. The train was late.	The train was late due to a breakdown.
10/10/55	10:15	Left the station. The train was on time.	The train was on time.
10/10/55	10:30	Arrived at the station. The train was late.	The train was late due to a breakdown.
10/10/55	10:45	Left the station. The train was on time.	The train was on time.
10/10/55	11:00	Arrived at the station. The train was late.	The train was late due to a breakdown.
10/10/55	11:15	Left the station. The train was on time.	The train was on time.

Table 4. (continued)

Principles from Berman's List	Some Teaching Aids Used
12. In sexual reproduction, a male cell from one parent unites with a female cell from the other parent to produce the young (except in the few cases of self-fertilization).	12.(a) Self-fertilizing and cross-fertilizing flowers examined in class. (b) Close-up photographs of techniques used in controlled fertilization shown.
13. Heredity supplies the native capacities of an organism; environment determines to a large extent how fully these capacities will be developed.	13.(a) On Harvard Museum trip various types of model hybrid fruits examined.
14. All plant and animal life, along with the climate and varying weather, play an active part in helping to form and to change the soil.	14.(a) Many photos of erosion shown. (b) Reports on reforestation efforts given.
15. Infection by micro-organisms is possible only under the following conditions: 1. The infecting organism must enter the host in sufficient number. 2. It must enter by an appropriate avenue. 3. It must be virulent. 4. The host must be receptive.	15.(a) Teaching aids used were similar to those for Principle #6 but applied to diptheria and related diseases.
16. Fossils, dated by the rocks in which they are found, reveal portions of the actual history of life's past changes by a progression of forms from simple to complex.	16.(a) Fossils and photographs of fossils shown to class. (b) Models of ancient animals made by some students.

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Table 4. (concluded)

Principles from Berman's List	Some Teaching Aids Used
17. The surface of the earth and the atmosphere surrounding the earth are undergoing constant changes....	17.(a) Different types of soil examined by students. (b) Small hillside grown with grass and devoid of vegetation, washed with water and the amount of soil washed away on each noted.
18. All heritable variations, which are not the results of recombinations of genes, are mutations which are changes in genes, in some cases induced by environmental agents.	18.(a) Student reports on Mendel's work. (b) Recent plants produced by mutation and selection shown to class.
19. An animal cannot live without proteins. They are necessary in cell growth and maintenance; so, are necessities in the diets of animals. Plants are able to use carbohydrates and nitrates to build up the proteins necessary for growth and maintenance of their cells.	19.(a) Photographs of nitrogen-fixing bacteria shown to the class. (b) Legumes on soy beans and clover examined by children.
Three concepts. (a) Essential amino acids (proteins) are necessary to build and maintain tissues. (b) Plants can build their own essential amino acids (proteins) from carbohydrates and nitrates. (c) Animals are dependent, directly or indirectly, on plants for their essential amino acids (proteins).	



## CHAPTER IV

### FINDINGS, SUMMARY, RECOMMENDATIONS

#### Findings

The results of this experiment may be considered from two viewpoints, (1) the individual achievement of the children, and (2) the achievement of the class as a whole.

All of the children did grow as Table 5 shows. In fact, only three of the 19 were below the 50% achievement place. Nine out of the 19 were above the 75% mark. One student had 100% growth. A comparison of IQ's shows this student to rank 13th in this class with a mean IQ of 106. Another student ranking ninth in this class had the second best achievement record of 90.90%. Some who did not show this marked increase in learning did not have as much room for growth as others. On a whole, those with greater mental ability made a better showing. This was to be expected.

The class as a group did well. The average percent of growth for the class was about 70%.

#### Summary

Since this is the first result of a study, some improvements could undoubtedly be made to increase the



percentage of growth in the class. Since the ninth grade curriculum is so full and time is limited it might be well, over a period of several years, to devote more attention to a few principles each year in an attempt to find the best ways of presenting them to the class. Table 3 shows which items were most difficult for the class, hence which principles were poorly understood.

The results as stated above are shown in Table 5, and indicate that the experiment was a worthwhile learning experience for the students. On the post test, out of the 19 principles that had been taught in the ten week period, the class on an average learned 16.5 principles or 87% of the material. The writer believes that this shows very clearly then that there was a high degree of success in this exercise.

This successful result may be attributed to several factors in the course of study. Very few straight lecture-type classes were held. Many facets were provided to the study of each principle. The class was taken on several trips to visit places of interest, objects related to the principles were brought to class for the children to see, demonstrations were performed, and reports were written and given orally by the children. All in all, a great deal of activity enabled the students to keep their attention, according to some of their other teachers, on science a great deal of the time.

percentage of 25% in the class, which is the only one  
mentioned in the text. It is stated in the text that  
over a period of several years, the company has been  
a low level in the market in the last  
year of operation. The company has been  
in the market for several years, and the  
market has been very good.

The company has been in the market for several years  
and has been very successful. The company has been  
in the market for several years, and the  
market has been very good. The company has been  
in the market for several years, and the  
market has been very good. The company has been  
in the market for several years, and the  
market has been very good.

The company has been in the market for several years  
and has been very successful. The company has been  
in the market for several years, and the  
market has been very good. The company has been  
in the market for several years, and the  
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in the market for several years, and the  
market has been very good.

Table 5. Results of the Am pretest and Bm post test Showing the Individual Growth of Each Pupil in the Ten Week Period

Student	IQ	Possible Score: 19		Possible Growth	Actual Growth	Percent of Growth Achieved
		No. Right on Pretest	No. Right on Post Test			
A	115	13	18	6	5	83.33
B	103	14	17	5	3	60.00
C	107	12	17	7	5	71.40
D	110	13	18	6	5	83.33
E	128	10	18	9	8	88.88
F	110	11	17	8	6	75.00
G	109	14	16	5	2	40.00
H	90	11	16	8	5	62.50
I	104	8	18	11	10	90.90
J	94	11	18	8	7	87.50
K	160	11	18	8	7	87.50
L	104	10	17	9	7	77.77
M	94	7	19	12	12	100.00
N	118	14	16	5	2	40.00
O	94	10	16	9	6	66.66
P	85	11	16	8	5	62.50
Q	83	7	14	12	7	58.33
R	111	7	10	12	3	25.00
S	104	7	13	12	6	50.00



### Recommendations

Basically, the approach to this problem has from the results seemed sound. The more avenues of perception we use, the more understanding a person will have of a principle. Perhaps more use should be made of presenting any one principle in several different ways. We learn not only by hearing, but by seeing, handling and smelling. These avenues of perception should be used.

There are other principles to be studied. Only because of previous studies and the availability of the Read General Science Test was this experiment possible. Other areas of ninth grade science should be studied in a similar manner, and other grade levels would no doubt profit by such a study.

In short, we must find what principles are valid and then find the most efficient way of teaching them.



# READ GENERAL SCIENCE TEST

JOHN G. READ

Author of "General Science" and "General Science Textbook"

Am

1914-1915

For use in the schools of the United States

The purpose of this book is to provide a general survey of the sciences of physics, chemistry, and biology. It is designed for use in the high school and is intended to be a general survey of the sciences of physics, chemistry, and biology. The book is intended to be a general survey of the sciences of physics, chemistry, and biology. The book is intended to be a general survey of the sciences of physics, chemistry, and biology. The book is intended to be a general survey of the sciences of physics, chemistry, and biology.

## APPENDIX

- 1. Physics
- 2. Chemistry
- 3. Biology
- 4. Zoology
- 5. Botany

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1871

# READ GENERAL SCIENCE TEST

BY JOHN G. READ

SCHOOL OF EDUCATION, BOSTON UNIVERSITY

FORM **Am**

## DIRECTIONS:

*Do not open this booklet until you are told to do so.*

This is a test of your knowledge of general science. For each question there are five possible answers. You are to decide which answer is the best one. You may answer a question even when you are not perfectly sure that your answer is correct, but you should avoid wild guessing. Do not spend too much time on any one question. You are *not* expected to be able to answer all the questions. Do not worry if you find a question on something you have not covered in class.

Study the sample questions below, and notice how the answers are marked on the separate answer sheet.

*Sample A.* The correct name for fluffy summer clouds is —

1. cirrus.
2. stratus.
3. nimbus.
4. cumulus.
5. thunder.

For Sample A the correct answer, of course, is "cumulus," which is answer 4. Now look at your answer sheet. At the top of the page in the left-hand column is a box marked SAMPLES. In the five answer spaces after Sample A, a heavy mark has been made filling the space (the pair of dotted lines) marked 4.

*Sample B.* The man known as the "wizard of the plant kingdom" was —

6. Joseph Lister.
7. Louis Pasteur.
8. Luther Burbank.
9. Thomas Edison.
10. none of the above.

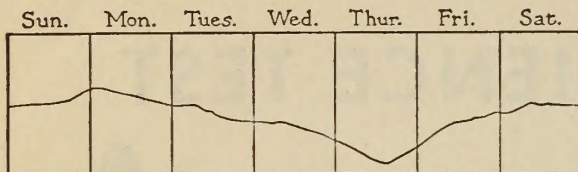
The correct answer for Sample B is "Luther Burbank," which is answer 8; so you would answer Sample B by making a heavy black mark that fills the space under the number 8. Do this now. If the correct answer had not been given, you would have chosen answer 10, "none of the above."

Read each question carefully and decide which one of the answers is best. Notice what number your choice is. Then, on the separate answer sheet, make a heavy black mark in the space under that number. In marking your answers, always be sure that the question number in the test booklet is the same as the question number on the answer sheet. Erase completely any answer you wish to change, and be careful not to make stray marks of any kind on your answer sheet or on your test booklet. When you finish a page, go on to the next page. If you finish the entire test before the time is up, go back and check your answers. Work as rapidly and as accurately as you can.

When you are told to do so, open your booklet to page 2 and begin. The working time for this test is 40 minutes.

1. Which one of the following causes the wind to blow?

1. differences in air pressure
2. moving tree branches
3. attraction of the moon
4. the presence of water vapor in the air
5. dust in the air



2. On what day, according to the above graph of barometric pressure, did a very bad storm occur?

6. Monday
7. Tuesday
8. Wednesday
9. Thursday
10. Friday

3. If three dishes of vanilla ice cream and one of chocolate ice cream are set on a table out-of-doors, the chocolate ice cream will melt the fastest because —

1. it is always softer when it is in the package.
2. it reflects the heat better.
3. it absorbs heat because it is colder.
4. it radiates heat because it is thicker.
5. it absorbs more heat because it is dark in color.

4. Foods are heated when canned to —

6. kill the bacteria.
7. keep the color of the food.
8. remove the moisture.
9. improve the quality.
10. increase the air pressure.

5. Which one of the following statements is FALSE?

1. It is better never to drink when driving.
2. It is practically certain that alcohol will slow down your reaction time.
3. Alcohol is considered to be a poor food.
4. Everyone can take one drink without having it affect him.
5. Alcohol is often habit-forming, and its users find it difficult to stop drinking.

6. Pasteur is known for his work with —

6. electricity.
7. bacteria.
8. molds.
9. radium.
10. X rays.

7. One danger with most fuels is that when they are burned they may produce —

1. carbon tetrachloride.
2. carbon monoxide.
3. nitrogen monoxide.
4. hydrogen.
5. oxygen.

8. Charges of electricity which move along a copper wire and which make up an electric current are called —

6. protons.
7. positrons.
8. neutrons.
9. electrons.
10. deuterons.

9. Which word does NOT describe a form of energy?

1. crystalline
2. electrical
3. atomic
4. mechanical
5. radiant

10. There is night and day because the —

6. earth revolves around the sun.
7. moon revolves around the sun.
8. earth rotates on its axis.
9. sun revolves around the earth.
10. moon rotates on its axis.

11. Most erosion in the upper Mississippi Valley was caused by the —

1. mining of iron.
2. mining of coal.
3. cutting of timber.
4. building of dams.
5. building of hydroelectric plants.

12. Which one of the following is NOT a color obtained when white light passes through a prism?

6. red
7. yellow
8. brown
9. green
10. indigo

13. If an extremely long-needed variety of pine tree produced some cones whose seeds grew into short-needed trees, it indicated that —

1. the parent pine tree was getting old.
2. there was not enough rain that year.
3. pollen from a hemlock tree reached the long-needed tree.
4. pollen from a short-needed pine fertilized the long-needed tree.
5. the seeds of the pine were damaged by squirrels.

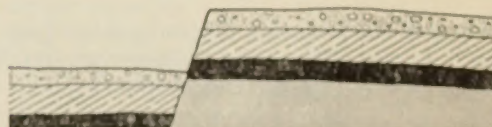
14. Most of the northern part of the United States is covered with sand and gravel deposited by —

6. tidal waves.
7. sandstorms.
8. hurricanes.
9. meteor showers.
10. glaciers.

15. In an automobile, oil is used in the —

1. radiator.
2. crankcase.
3. vacuum tank.
4. gasoline filter.
5. ignition coil.

16. Which one of the following is most necessary for proper growth of the bones?
6. calcium
  7. iron
  8. fluorine
  9. iodine
  10. carbon
17. It is possible to contract tuberculosis ONLY if one —
1. loses weight.
  2. comes in contact with the tuberculosis bacillus.
  3. gets overtired.
  4. does not get enough fresh air at night.
  5. is bitten by a certain kind of mosquito.
18. Sound vibrations from the human voice are changed to electrical energy in the —
6. telegraph.
  7. teletype.
  8. telautograph.
  9. teleportation.
  10. telephone.
19. Which one of the following statements about air on a mountain top is true?
1. It has color.
  2. It has odor.
  3. It has weight.
  4. It is visible.
  5. It has taste.
20. At present most gasoline comes from —
6. petroleum.
  7. kerosene.
  8. natural gas.
  9. plant oils.
  10. coal.
21. On a sunny spring morning, spider webs in the grass were covered with tiny drops of dew. Where had the dew come from?
1. the air
  2. the grass
  3. the spiders
  4. the morning sunlight
  5. melted frost
22. Which one of the following is replaceable as it is NOT a natural resource of the country?
6. nickel
  7. plastics
  8. tungsten
  9. petroleum
  10. copper
23. Two explorers measured the height of the same mountain in Alaska — one in 1898, the other in 1940. Their results were different by over 500 feet. Which one of the following best explains this discrepancy?
1. The 1898 figure was obtained in the summer.
  2. The 1940 figure was obtained in the winter.
  3. The 1898 figure was obtained by climbing the mountain.
  4. The 1940 survey was by airplane, using photographic mapping.
  5. None of the above gives a completely satisfactory explanation.
24. Which pair of terms is correctly matched?
6. Sun — satellite
  7. Neptune — planet
  8. Meteor — star
  9. Moon — asteroid
  10. Comet — sunspot
25. A green vegetable like lettuce is valuable in the diet because it supplies —
1. carbohydrates.
  2. fats.
  3. proteins.
  4. vitamins.
  5. all of the above.
26. Which one of the following causes the handle of an aluminum saucepan on a gas stove to become very hot, although the handle is not over the flame?
6. convection
  7. evaporation
  8. radiation
  9. insulation
  10. conduction
27. In poems and legends, ships which have sunk are said to
- "Float forever and forever  
Halfway between the ocean floor  
And stormy waves above."*
- These ships are thought to reach a point where the water is so dense that they will not sink. Why is this FALSE?
1. Wooden ships would be broken up by the water.
  2. Metal plates on ships would bend under the great pressure.
  3. Water can be compressed very little. Therefore, its density cannot be increased very much.
  4. Ships with cargoes which will float cannot be sunk.
  5. Salt water is much more dense than fresh water.



28. The geological formation above constitutes evidence of —
6. volcanic action.
  7. erosion.
  8. folding.
  9. sedimentation in a running stream.
  10. movement in the earth's crust.
29. The distinctive shape of "Green Mountain" potatoes is due primarily to the —
1. amount of cultivation they receive.
  2. amount of rainfall.
  3. hereditary character of the seed potatoes.
  4. amount of fertilizer applied.
  5. temperature during the growing season.

30. Which one of the following does NOT refract light?

6. eyeglasses
7. microscope
8. Galilean telescope
9. mirror
10. reading or magnifying glasses

31. Which one of the following does NOT usually carry bacteria which are harmful to man?

1. ticks
2. flies
3. mosquitoes
4. fleas
5. bees

32. It had been a clear, cold November day with the temperature at 25° F. That night at the railroad yards a leaky steam pipe sent a white cloud of steam into the air all night. The temperature remained at 25° F. In the morning what would probably be on the ground near the leaky steam pipe?

6. dew
7. sleet
8. frost
9. hail
10. steam

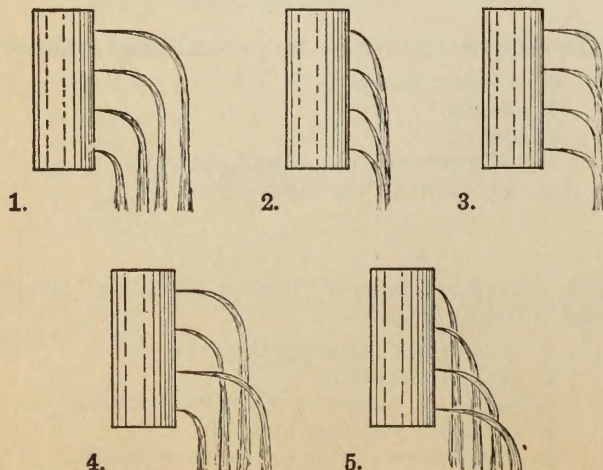
33. Many low, rounded banks of sand, boulders, and pebbles were probably formed by —

1. glaciers.
2. meteor showers.
3. tidal waves.
4. sandstorms.
5. hurricanes.

34. A comic-book science story showed a man building a big balloon out of very thin sheets of aluminum cemented together so as to be airtight. He pumped the air out of the balloon, and the balloon then floated. At present this would be impossible because —

6. aluminum cannot be made airtight.
7. it would take too much cement.
8. the outside air pressure would crush the balloon.
9. the balloon would not hold hydrogen.
10. aluminum is too heavy.

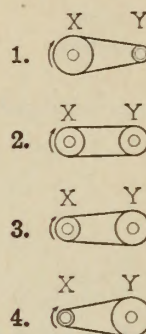
35. Which one of the following diagrams shows best what will happen if 4 holes of the same diameter are punched at the same time in a tall tin can full of water?



36. Which one of the following is an example of a chemical change?

6. melting wax
7. breaking glass
8. burning wood
9. crushing stone
10. freezing water

37. If pulley X is turning at 178 revolutions per minute, the arrangement of pulleys that will give pulley Y the lowest speed of rotation is —



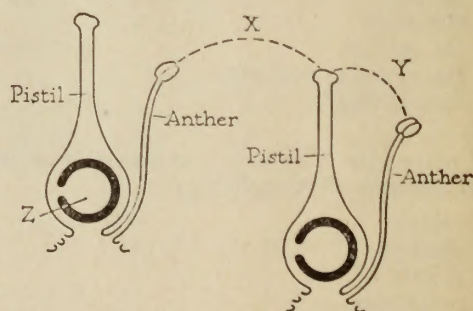
5. none of the above

38. About every seven years everyone should be vaccinated against —

6. typhoid fever.
7. diphtheria.
8. smallpox.
9. influenza.
10. colds.

39. After the explosion of the gasoline occurs in a cylinder of an automobile engine, the next action in that cylinder is —

1. intake.
2. exhaust.
3. compression.
4. carburetion.
5. suction.



40. The process shown above at Y is called —

6. self-pollination.
7. cross-fertilization.
8. mutation.
9. cell division.
10. budding.

41. A dynamo causes electricity to flow by —

1. chemical action.
2. moving a coil of wire across a magnetic field.
3. moving a coil of wire in a storage battery.
4. moving static electrical charges to an insulator.
5. none of the above.

42. Which pair of terms is correctly matched?

6. speed of light — 93,000,000
7. rotation of the earth — 186,000
8. revolution of the earth —  $365\frac{1}{4}$
9. distance from earth to sun — 240,000
10. none of the above

43. Tracks of dinosaurs left on the muddy banks of streams are found now as fossils. About how many years ago were they made?

1. 1 thousand
2. 10 thousand
3. 50 thousand
4. 100 thousand
5. 1 million

44. Why does heat make iron easier to shape?

6. Heat often causes the iron to become red.
7. Heat increases the motion of molecules.
8. Heat causes the iron molecules to expand.
9. Heat decreases the elasticity of the iron.
10. Heat increases the density of the iron.

45. Musical sounds result ONLY from what kind of vibrations?

1. amplified
2. supersonic
3. regular
4. slow
5. fast

46. Astrologers use the position of the stars and the planets at the hour, day, and minute of a person's birth to predict his future. Which one of the following statements regarding this practice is true?

6. The modern astrologer can now predict one's future more accurately because there are better telescopes in use.
7. Some astrologers inherit the ability to understand the stars from their mothers or their fathers.
8. Study and long years of training in astrology make an astrologer's predictions of one's future more accurate.
9. Very good astrologers are worth the high fees which they charge.
10. Scientific evidence has not shown that astrologers can predict the future of an individual on the basis of what they know about the stars.

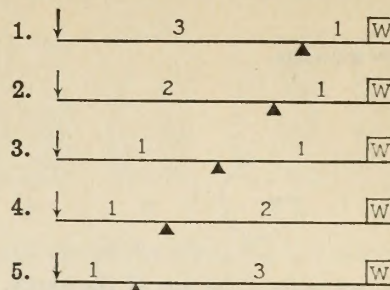
47. Which one is NOT a lever?

1. pencil sharpener
2. seesaw
3. derrick
4. fishing rod
5. scissors

48. Which one of the following statements is true and applies both to magnets and to static electricity?

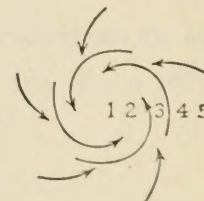
6. Copper particles are attracted.
7. Like charges or poles repel.
8. Paper is attracted.
9. Fires may be started.
10. Unlike charges or poles repel.

49. If a 500-pound weight is placed at the arrow, which lever will lift the 60-pound weight W the highest?



50. Which pair of terms is correctly matched?

6. Ursa Major — Big Dipper
7. Ursa Minor — Little Dog
8. Cassiopeia — Dipper
9. Polaris — The W
10. Orion — Milky Way



51. A warm cyclonic storm moves across the country from west to east in July. Winds blow strongly toward its center and rain falls near the edge of the whirling mass of air. In the diagram above the place where the temperature is most likely to be the lowest is at point —

1. 1
2. 2
3. 3
4. 4
5. 5

52. A pulley arrangement which gives NO mechanical advantage is the —

6. single movable.
7. single fixed.
8. double movable, single fixed.
9. double fixed, single movable.
10. double movable, double fixed.

53. What part of the blood is effective in destroying invading bacteria?

1. plasma
2. red corpuscles
3. toxin
4. white corpuscles
5. lymph

54. The chemical name of the gas which is produced when coal is burned with plenty of oxygen is —

6. carbon tetrachloride.
7. nitrogen.
8. hydrogen.
9. carbon dioxide.
10. water gas.

55. Penicillin is obtained from —

1. molds.
2. bacteria.
3. vaccines.
4. laboratory animals.
5. serums.



56. The circle above represents the age of the earth, and the shaded part represents the time that civilization may have existed. About how many years are represented by the shaded portion?

6. 50 thousand
7. 750 thousand
8. 30 million
9. 100 million
10. 1 billion

57. A large soap bubble will rise in the air if it is filled with —

1. carbon dioxide.
2. air.
3. nitrogen.
4. oxygen.
5. hydrogen.

58. In an experiment, an iron ball at a temperature of  $200^{\circ}\text{F}$ . was placed in a pan and covered with water whose temperature was  $72^{\circ}\text{F}$ . The room temperature was  $70^{\circ}\text{F}$ . After 10 minutes the temperature of both ball and water was measured and found to be about —

6.  $72^{\circ}\text{F}$ .
7.  $150^{\circ}\text{F}$ .
8.  $200^{\circ}\text{F}$ .
9.  $201^{\circ}\text{F}$ .
10.  $272^{\circ}\text{F}$ .

59. A vital factor in producing a new variety of tomatoes is —

1. selection of the best seed.
2. self-pollination.
3. good soil.
4. plenty of moisture.
5. cross-pollination.

60. Which one of the following has probably had the LEAST over-all effect in the breaking down of rocks into soil?

6. running water
7. wind, carrying sand
8. tides
9. explosives used by man
10. chemical changes

61. Which pair of terms is correctly matched?

1. longer string — higher pitch
2. heavier string — higher pitch
3. slower vibration — lower pitch
4. faster vibration — lower pitch
5. None of them is matched correctly.

62. The oxygen in the air is necessary for all EXCEPT which one of the following?

6. decay of wood
7. burning
8. respiration
9. rusting
10. photosynthesis

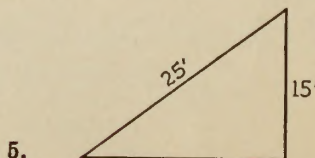
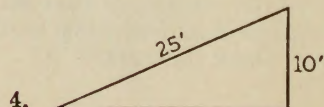
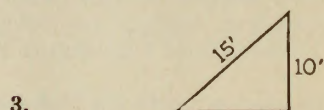
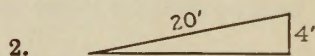
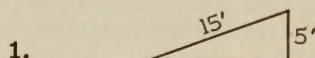
63. In January a warm cloud from which rain fell moved from the south northward. When it reached Vermont, the rain changed to snow. What probably caused the change?

1. The lakes were frozen.
2. Not enough moisture was left in the cloud for it to rain.
3. The temperature of the air around the cloud was  $36^{\circ}\text{F}$ .
4. The air temperature at the cloud level was  $25^{\circ}\text{F}$ .
5. The direction of the wind changed.

64. Radar depends for its operation on an electronic tube which sends out pulses of energy, and on a device called the —

6. spectroscope.
7. oscilloscope.
8. telescope.
9. camera.
10. projector.

65. A 125-pound box on rollers is pushed up an inclined plane. Which inclined plane will require the greatest force to move the box?



66. An acid used in the home is —

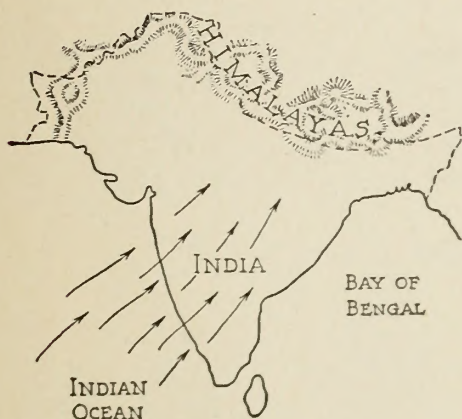
6. soap powder.
7. bicarbonate of soda.
8. onion juice.
9. vinegar.
10. salt.

67. If each one of the following was expressed by a number, which one would be the largest?

1. speed of light in miles per second
2. distance from the earth to the sun in miles
3. distance from the earth to the moon in miles
4. number of days necessary for one revolution of the earth
5. number of miles in a light-year

68. A sailboat going from a point 100 miles up the Mississippi River to the ocean without stopping would —

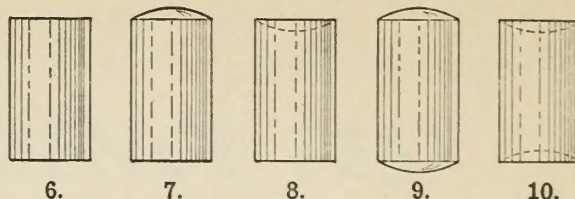
6. float higher in the ocean.
7. float lower in the ocean.
8. weigh less in the river.
9. weigh less in the ocean.
10. be buoyed up less by the ocean.



69. About May 20, a southwest wind called the "wet monsoon" begins to blow over most of India from the tropical Indian Ocean toward the Himalayas. Tremendous thunderstorms occur, and then the rainy season continues for two or three months. The best reason why it rains so long over most of India is that the —

1. cool air from the mountains is saturated with moisture.
2. warm air from the ocean is cooled over the land.
3. warm dry air bumps into cool mountain peaks.
4. cool air from the ocean carries more water.
5. cool air from the mountains has picked up snow from the peaks of the Himalayas.

70. If a large empty tomato-juice can is completely sealed and then placed in a glass container from which most of the air is pumped, the can then will most resemble diagram —



71. Which one of the following is a compound?

1. sugar
2. iron
3. hydrogen
4. sulfur
5. mercury

72. The resistance of conductors of electric current is measured in —

6. volts.
7. watts.
8. amperes.
9. ohms.
10. coulombs.

73. Which one of the following is NOT a legume?

1. string beans
2. soybeans
3. corn
4. clover
5. alfalfa

74. If a friend says, "Oh, nobody in my family ever had diphtheria, so I won't ever have it," you might properly make all EXCEPT which one of the following statements?

6. "We can ask the school doctor about diphtheria."
7. "Let's look it up in a health book."
8. "I had the diphtheria toxoid and now I probably won't have diphtheria."
9. "Maybe you are right."
10. "I don't believe that immunity from diphtheria is hereditary."

75. If a completely new kind of melon appeared in a melon patch, and this new type of melon reproduced the same kind of melons from its seeds, the cause of this new type of melon probably was —

1. injury to the melon blossom.
2. mutation.
3. an extra amount of fertilizer.
4. self-pollination.
5. cell division.

Go back and check your answers.

ALCANTARA

12

GENERAL EDITOR: WALTER N. DUROST, SCHOOL OF EDUCATION, BOSTON UNIVERSITY

COORDINATOR FOR SCIENCE TESTS: VICTOR H. NOLL, MICHIGAN STATE COLLEGE

# READ GENERAL SCIENCE TEST

BY JOHN G. READ

SCHOOL OF EDUCATION, BOSTON UNIVERSITY

FORM **Am**

## DIRECTIONS:

*Do not open this booklet until you are told to do so.*

This is a test of your knowledge of general science. For each question there are five possible answers. You are to decide which answer is the best one. You may answer a question even when you are not perfectly sure that your answer is correct, but you should avoid wild guessing. Do not spend too much time on any one question. You are *not* expected to be able to answer all the questions. Do not worry if you find a question on something you have not covered in class.

Study the sample questions below, and notice how the answers are marked on the separate answer sheet.

*Sample A.* The correct name for fluffy summer clouds is —

1. cirrus.
2. stratus.
3. nimbus.
4. cumulus.
5. thunder.

For Sample A the correct answer, of course, is "cumulus," which is answer 4. Now look at your answer sheet. At the top of the page in the left-hand column is a box marked SAMPLES. In the five answer spaces after Sample A, a heavy mark has been made filling the space (the pair of dotted lines) marked 4.

*Sample B.* The man known as the "wizard of the plant kingdom" was —

6. Joseph Lister.
7. Louis Pasteur.
8. Luther Burbank.
9. Thomas Edison.
10. none of the above.

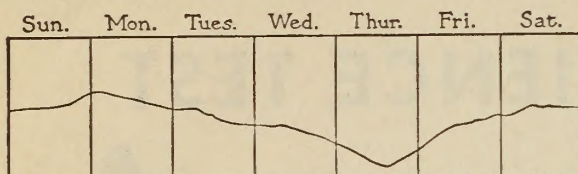
The correct answer for Sample B is "Luther Burbank," which is answer 8; so you would answer Sample B by making a heavy black mark that fills the space under the number 8. Do this now. If the correct answer had not been given, you would have chosen answer 10, "none of the above."

Read each question carefully and decide which one of the answers is best. Notice what number your choice is. Then, on the separate answer sheet, make a heavy black mark in the space under that number. In marking your answers, always be sure that the question number in the test booklet is the same as the question number on the answer sheet. Erase completely any answer you wish to change, and be careful not to make stray marks of any kind on your answer sheet or on your test booklet. When you finish a page, go on to the next page. If you finish the entire test before the time is up, go back and check your answers. Work as rapidly and as accurately as you can.

When you are told to do so, open your booklet to page 2 and begin. The working time for this test is 40 minutes.

1. Which one of the following causes the wind to blow?

1. differences in air pressure
2. moving tree branches
3. attraction of the moon
4. the presence of water vapor in the air
5. dust in the air



2. On what day, according to the above graph of barometric pressure, did a very bad storm occur?

6. Monday
7. Tuesday
8. Wednesday
9. Thursday
10. Friday

3. If three dishes of vanilla ice cream and one of chocolate ice cream are set on a table out-of-doors, the chocolate ice cream will melt the fastest because —

1. it is always softer when it is in the package.
2. it reflects the heat better.
3. it absorbs heat because it is colder.
4. it radiates heat because it is thicker.
5. it absorbs more heat because it is dark in color.

4. Foods are heated when canned to —

6. kill the bacteria.
7. keep the color of the food.
8. remove the moisture.
9. improve the quality.
10. increase the air pressure.

5. Which one of the following statements is FALSE?

1. It is better never to drink when driving.
2. It is practically certain that alcohol will slow down your reaction time.
3. Alcohol is considered to be a poor food.
4. Everyone can take one drink without having it affect him.
5. Alcohol is often habit-forming, and its users find it difficult to stop drinking.

6. Pasteur is known for his work with —

6. electricity.
7. bacteria.
8. molds.
9. radium.
10. X rays.

7. One danger with most fuels is that when they are burned they may produce —

1. carbon tetrachloride.
2. carbon monoxide.
3. nitrogen monoxide.
4. hydrogen.
5. oxygen.

8. Charges of electricity which move along a copper wire and which make up an electric current are called —

6. protons.
7. positrons.
8. neutrons.
9. electrons.
10. deuterons.

9. Which word does NOT describe a form of energy?

1. crystalline
2. electrical
3. atomic
4. mechanical
5. radiant

10. There is night and day because the —

6. earth revolves around the sun.
7. moon revolves around the sun.
8. earth rotates on its axis.
9. sun revolves around the earth.
10. moon rotates on its axis.

11. Most erosion in the upper Mississippi Valley was caused by the —

1. mining of iron.
2. mining of coal.
3. cutting of timber.
4. building of dams.
5. building of hydroelectric plants.

12. Which one of the following is NOT a color obtained when white light passes through a prism?

6. red
7. yellow
8. brown
9. green
10. indigo

13. If an extremely long-needled variety of pine tree produced some cones whose seeds grew into short-needled trees, it indicated that —

1. the parent pine tree was getting old.
2. there was not enough rain that year.
3. pollen from a hemlock tree reached the long-needled tree.
4. pollen from a short-needled pine fertilized the long-needled tree.
5. the seeds of the pine were damaged by squirrels.

14. Most of the northern part of the United States is covered with sand and gravel deposited by —

6. tidal waves.
7. sandstorms.
8. hurricanes.
9. meteor showers.
10. glaciers.

15. In an automobile, oil is used in the —

1. radiator.
2. crankcase.
3. vacuum tank.
4. gasoline filter.
5. ignition coil.

16. Which one of the following is most necessary for proper growth of the bones?

6. calcium
7. iron
8. fluorine
9. iodine
10. carbon

17. It is possible to contract tuberculosis ONLY if one —

1. loses weight.
2. comes in contact with the tuberculosis bacillus.
3. gets overtired.
4. does not get enough fresh air at night.
5. is bitten by a certain kind of mosquito.

18. Sound vibrations from the human voice are changed to electrical energy in the —

6. telegraph.
7. teletype.
8. telautograph.
9. teleportation.
10. telephone.

19. Which one of the following statements about air on a mountain top is true?

1. It has color.
2. It has odor.
3. It has weight.
4. It is visible.
5. It has taste.

20. At present most gasoline comes from —

6. petroleum.
7. kerosene.
8. natural gas.
9. plant oils.
10. coal.

21. On a sunny spring morning, spider webs in the grass were covered with tiny drops of dew. Where had the dew come from?

1. the air
2. the grass
3. the spiders
4. the morning sunlight
5. melted frost

22. Which one of the following is replaceable as it is NOT a natural resource of the country?

6. nickel
7. plastics
8. tungsten
9. petroleum
10. copper

23. Two explorers measured the height of the same mountain in Alaska — one in 1898, the other in 1940. Their results were different by over 500 feet. Which one of the following best explains this discrepancy?

1. The 1898 figure was obtained in the summer.
2. The 1940 figure was obtained in the winter.
3. The 1898 figure was obtained by climbing the mountain.
4. The 1940 survey was by airplane, using photographic mapping.
5. None of the above gives a completely satisfactory explanation.

24. Which pair of terms is correctly matched?

6. Sun — satellite
7. Neptune — planet
8. Meteor — star
9. Moon — asteroid
10. Comet — sunspot

25. A green vegetable like lettuce is valuable in the diet because it supplies —

1. carbohydrates.
2. fats.
3. proteins.
4. vitamins.
5. all of the above.

26. Which one of the following causes the handle of an aluminum saucepan on a gas stove to become very hot, although the handle is not over the flame?

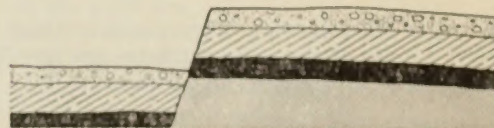
6. convection
7. evaporation
8. radiation
9. insulation
10. conduction

27. In poems and legends, ships which have sunk are said to

*"Float forever and forever  
Halfway between the ocean floor  
And stormy waves above."*

These ships are thought to reach a point where the water is so dense that they will not sink. Why is this FALSE?

1. Wooden ships would be broken up by the water.
2. Metal plates on ships would bend under the great pressure.
3. Water can be compressed very little. Therefore, its density cannot be increased very much.
4. Ships with cargoes which will float cannot be sunk.
5. Salt water is much more dense than fresh water.



28. The geological formation above constitutes evidence of —

6. volcanic action.
7. erosion.
8. folding.
9. sedimentation in a running stream.
10. movement in the earth's crust.

29. The distinctive shape of "Green Mountain" potatoes is due primarily to the —

1. amount of cultivation they receive.
2. amount of rainfall.
3. hereditary character of the seed potatoes.
4. amount of fertilizer applied.
5. temperature during the growing season.

30. Which one of the following does NOT refract light?

6. eyeglasses
7. microscope
8. Galilean telescope
9. mirror
10. reading or magnifying glasses

31. Which one of the following does NOT usually carry bacteria which are harmful to man?

1. ticks
2. flies
3. mosquitoes
4. fleas
5. bees

32. It had been a clear, cold November day with the temperature at 25° F. That night at the railroad yards a leaky steam pipe sent a white cloud of steam into the air all night. The temperature remained at 25° F. In the morning what would probably be on the ground near the leaky steam pipe?

6. dew
7. sleet
8. frost
9. hail
10. steam

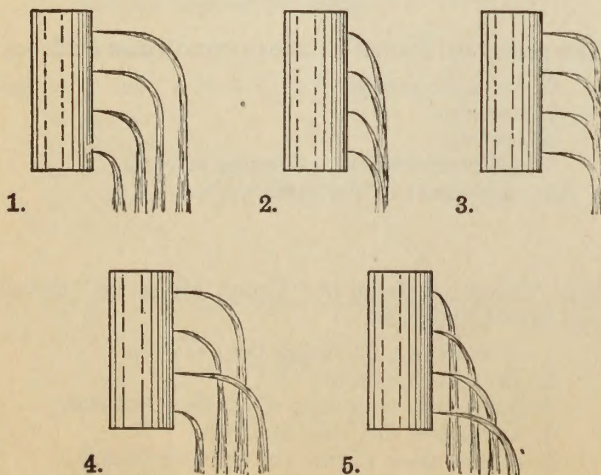
33. Many low, rounded banks of sand, boulders, and pebbles were probably formed by —

1. glaciers.
2. meteor showers.
3. tidal waves.
4. sandstorms.
5. hurricanes.

34. A comic-book science story showed a man building a big balloon out of very thin sheets of aluminum cemented together so as to be airtight. He pumped the air out of the balloon, and the balloon then floated. At present this would be impossible because —

6. aluminum cannot be made airtight.
7. it would take too much cement.
8. the outside air pressure would crush the balloon.
9. the balloon would not hold hydrogen.
10. aluminum is too heavy.

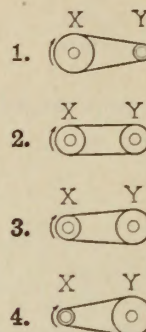
35. Which one of the following diagrams shows best what will happen if 4 holes of the same diameter are punched at the same time in a tall tin can full of water?



36. Which one of the following is an example of a chemical change?

6. melting wax
7. breaking glass
8. burning wood
9. crushing stone
10. freezing water

37. If pulley X is turning at 178 revolutions per minute, the arrangement of pulleys that will give pulley Y the lowest speed of rotation is —



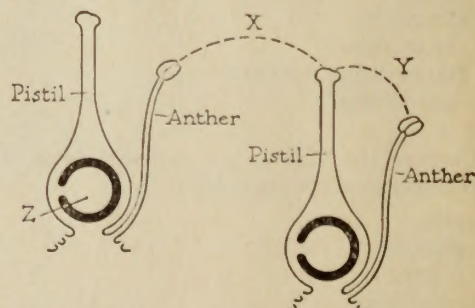
5. none of the above

38. About every seven years everyone should be vaccinated against —

6. typhoid fever.
7. diphtheria.
8. smallpox.
9. influenza.
10. colds.

39. After the explosion of the gasoline occurs in a cylinder of an automobile engine, the next action in that cylinder is —

1. intake.
2. exhaust.
3. compression.
4. carburetion.
5. suction.



40. The process shown above at Y is called —

6. self-pollination.
7. cross-fertilization.
8. mutation.
9. cell division.
10. budding.

41. A dynamo causes electricity to flow by —

1. chemical action.
2. moving a coil of wire across a magnetic field.
3. moving a coil of wire in a storage battery.
4. moving static electrical charges to an insulator.
5. none of the above.

42. Which pair of terms is correctly matched?

6. speed of light — 93,000,000
7. rotation of the earth — 186,000
8. revolution of the earth —  $365\frac{1}{4}$
9. distance from earth to sun — 240,000
10. none of the above

43. Tracks of dinosaurs left on the muddy banks of streams are found now as fossils. About how many years ago were they made?

1. 1 thousand
2. 10 thousand
3. 50 thousand
4. 100 thousand
5. 1 million

44. Why does heat make iron easier to shape?

6. Heat often causes the iron to become red.
7. Heat increases the motion of molecules.
8. Heat causes the iron molecules to expand.
9. Heat decreases the elasticity of the iron.
10. Heat increases the density of the iron.

45. Musical sounds result ONLY from what kind of vibrations?

1. amplified
2. supersonic
3. regular
4. slow
5. fast

46. Astrologers use the position of the stars and the planets at the hour, day, and minute of a person's birth to predict his future. Which one of the following statements regarding this practice is true?

6. The modern astrologer can now predict one's future more accurately because there are better telescopes in use.
7. Some astrologers inherit the ability to understand the stars from their mothers or their fathers.
8. Study and long years of training in astrology make an astrologer's predictions of one's future more accurate.
9. Very good astrologers are worth the high fees which they charge.
10. Scientific evidence has not shown that astrologers can predict the future of an individual on the basis of what they know about the stars.

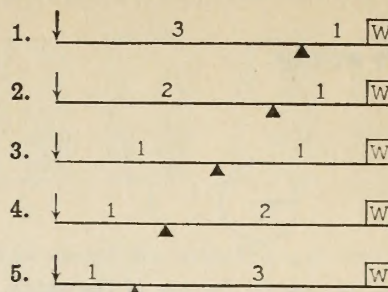
47. Which one is NOT a lever?

1. pencil sharpener
2. seesaw
3. derrick
4. fishing rod
5. scissors

48. Which one of the following statements is true and applies both to magnets and to static electricity?

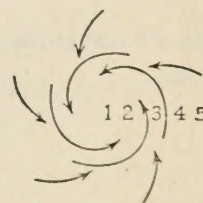
6. Copper particles are attracted.
7. Like charges or poles repel.
8. Paper is attracted.
9. Fires may be started.
10. Unlike charges or poles repel.

49. If a 500-pound weight is placed at the arrow, which lever will lift the 60-pound weight W the highest?



50. Which pair of terms is correctly matched?

6. Ursa Major — Big Dipper
7. Ursa Minor — Little Dog
8. Cassiopeia — Dipper
9. Polaris — The W
10. Orion — Milky Way



51. A warm cyclonic storm moves across the country from west to east in July. Winds blow strongly toward its center and rain falls near the edge of the whirling mass of air. In the diagram above the place where the temperature is most likely to be the lowest is at point —

1. 1
2. 2
3. 3
4. 4
5. 5

52. A pulley arrangement which gives NO mechanical advantage is the —

6. single movable.
7. single fixed.
8. double movable, single fixed.
9. double fixed, single movable.
10. double movable, double fixed.

53. What part of the blood is effective in destroying invading bacteria?

1. plasma
2. red corpuscles
3. toxin
4. white corpuscles
5. lymph

54. The chemical name of the gas which is produced when coal is burned with plenty of oxygen is —

6. carbon tetrachloride.
7. nitrogen.
8. hydrogen.
9. carbon dioxide.
10. water gas.

55. Penicillin is obtained from —

1. molds.
2. bacteria.
3. vaccines.
4. laboratory animals.
5. serums.



56. The circle above represents the age of the earth, and the shaded part represents the time that civilization may have existed. About how many years are represented by the shaded portion?

6. 50 thousand
7. 750 thousand
8. 30 million
9. 100 million
10. 1 billion

57. A large soap bubble will rise in the air if it is filled with —

1. carbon dioxide.
2. air.
3. nitrogen.
4. oxygen.
5. hydrogen.

58. In an experiment, an iron ball at a temperature of  $200^{\circ}\text{F}$ . was placed in a pan and covered with water whose temperature was  $72^{\circ}\text{F}$ . The room temperature was  $70^{\circ}\text{F}$ . After 10 minutes the temperature of both ball and water was measured and found to be about —

6.  $72^{\circ}\text{F}$ .
7.  $150^{\circ}\text{F}$ .
8.  $200^{\circ}\text{F}$ .
9.  $201^{\circ}\text{F}$ .
10.  $272^{\circ}\text{F}$ .

59. A vital factor in producing a new variety of tomatoes is —

1. selection of the best seed.
2. self-pollination.
3. good soil.
4. plenty of moisture.
5. cross-pollination.

60. Which one of the following has probably had the LEAST over-all effect in the breaking down of rocks into soil?

6. running water
7. wind, carrying sand
8. tides
9. explosives used by man
10. chemical changes

61. Which pair of terms is correctly matched?

1. longer string — higher pitch
2. heavier string — higher pitch
3. slower vibration — lower pitch
4. faster vibration — lower pitch
5. None of them is matched correctly.

62. The oxygen in the air is necessary for all EXCEPT which one of the following?

6. decay of wood
7. burning
8. respiration
9. rusting
10. photosynthesis

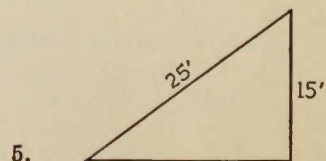
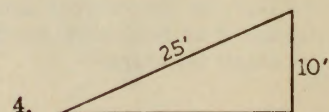
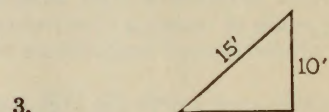
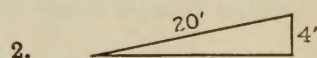
63. In January a warm cloud from which rain fell moved from the south northward. When it reached Vermont, the rain changed to snow. What probably caused the change?

1. The lakes were frozen.
2. Not enough moisture was left in the cloud for it to rain.
3. The temperature of the air around the cloud was  $36^{\circ}\text{F}$ .
4. The air temperature at the cloud level was  $25^{\circ}\text{F}$ .
5. The direction of the wind changed.

64. Radar depends for its operation on an electronic tube which sends out pulses of energy, and on a device called the —

6. spectroscope.
7. oscilloscope.
8. telescope.
9. camera.
10. projector.

65. A 125-pound box on rollers is pushed up an inclined plane. Which inclined plane will require the greatest force to move the box?



66. An acid used in the home is —

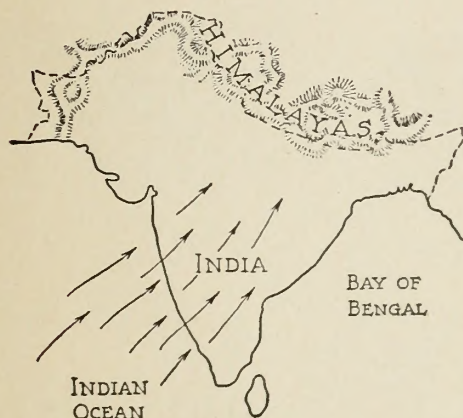
6. soap powder.
7. bicarbonate of soda.
8. onion juice.
9. vinegar.
10. salt.

67. If each one of the following was expressed by a number, which one would be the largest?

1. speed of light in miles per second
2. distance from the earth to the sun in miles
3. distance from the earth to the moon in miles
4. number of days necessary for one revolution of the earth
5. number of miles in a light-year

68. A sailboat going from a point 100 miles up the Mississippi River to the ocean without stopping would —

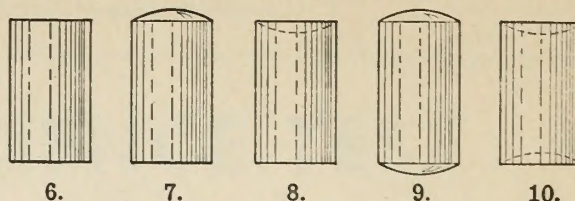
6. float higher in the ocean.
7. float lower in the ocean.
8. weigh less in the river.
9. weigh less in the ocean.
10. be buoyed up less by the ocean.



69. About May 20, a southwest wind called the "wet monsoon" begins to blow over most of India from the tropical Indian Ocean toward the Himalayas. Tremendous thunderstorms occur, and then the rainy season continues for two or three months. The best reason why it rains so long over most of India is that the —

1. cool air from the mountains is saturated with moisture.
2. warm air from the ocean is cooled over the land.
3. warm dry air bumps into cool mountain peaks.
4. cool air from the ocean carries more water.
5. cool air from the mountains has picked up snow from the peaks of the Himalayas.

70. If a large empty tomato-juice can is completely sealed and then placed in a glass container from which most of the air is pumped, the can then will most resemble diagram —



71. Which one of the following is a compound?

1. sugar
2. iron
3. hydrogen
4. sulfur
5. mercury

72. The resistance of conductors of electric current is measured in —

6. volts.
7. watts.
8. amperes.
9. ohms.
10. coulombs.

73. Which one of the following is NOT a legume?

1. string beans
2. soybeans
3. corn
4. clover
5. alfalfa

74. If a friend says, "Oh, nobody in my family ever had diphtheria, so I won't ever have it," you might properly make all EXCEPT which one of the following statements?

6. "We can ask the school doctor about diphtheria."
7. "Let's look it up in a health book."
8. "I had the diphtheria toxoid and now I probably won't have diphtheria."
9. "Maybe you are right."
10. "I don't believe that immunity from diphtheria is hereditary."

75. If a completely new kind of melon appeared in a melon patch, and this new type of melon reproduced the same kind of melons from its seeds, the cause of this new type of melon probably was —

1. injury to the melon blossom.
2. mutation.
3. an extra amount of fertilizer.
4. self-pollination.
5. cell division.

Go back and check your answers.

1. The first part of the paper is devoted to a general discussion of the problem. It is shown that the problem is of great importance in the theory of the structure of the atom.

2. In the second part of the paper, the author discusses the results of his calculations. It is shown that the results are in good agreement with the experimental data.

3. The third part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

4. The fourth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

5. The fifth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

6. The sixth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

7. The seventh part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

8. The eighth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

9. The ninth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

10. The tenth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

11. The eleventh part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

12. The twelfth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

13. The thirteenth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

14. The fourteenth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

15. The fifteenth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

16. The sixteenth part of the paper is devoted to a discussion of the results of the calculations. It is shown that the results are in good agreement with the experimental data.

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